

Di-electron Widths of the $\Upsilon(1S, 2S, 3S)$ Resonances

J. Pivarski

Cornell University, Ithaca, New York 14853

Abstract. We determine the di-electron widths of the $\Upsilon(1S)$, $\Upsilon(2S)$, and $\Upsilon(3S)$ resonances with better than 2% precision by integrating the cross-section of $e^+e^- \rightarrow \Upsilon$ over the e^+e^- center-of-mass energy. Using e^+e^- energy scans of the Υ resonances at the Cornell Electron Storage Ring and measuring Υ production with the CLEO detector, we find di-electron widths of 1.252 ± 0.004 ($\sigma_{\text{stat}} \pm 0.019$ (σ_{syst}) keV, $0.581 \pm 0.004 \pm 0.009$ keV, and $0.413 \pm 0.004 \pm 0.006$ keV for the $\Upsilon(1S)$, $\Upsilon(2S)$, and $\Upsilon(3S)$, respectively.

Keywords: Upsilon bottomonium di-electron di-lepton partial width resonance scan

PACS: 14.40.Nd, 12.20.Fv, 13.25.Gv

The widths of the Υ mesons, $b\bar{b}$ bound states discovered in 1977 [1], are related to the quark-antiquark spatial wave function at the origin [2]. Recently, these widths have been recognized as a testing ground for QCD lattice gauge theory calculations [3]. Improvements in the lattice calculations, such as the avoidance of the quenched approximation [4], provide an incentive for more accurate experimental tests. The di-electron widths (Γ_{ee}) of the $\Upsilon(1S)$, $\Upsilon(2S)$, and $\Upsilon(3S)$ have previously been measured with precisions of 2.2%, 4.2%, and 9.4%, respectively [5]. Validation of the lattice calculations at an accuracy of a few percent will increase confidence in similar calculations used to extract important weak-interaction parameters from data. In particular, Γ_{ee} and f_D [6] provide complementary tests of the calculation of f_B , which is used to determine the CKM parameter V_{td} .

At PANIC05, we presented preliminary measurements of Γ_{ee} which have since been supplanted by public final results, available in [7]. This reference covers the same experimental issues as our presentation. More detail will soon be available in [8]. The theoretical lattice prediction we referred to in our presentation has since been published in [3] (near the end). To avoid repetition, we refer the reader to these documents.

REFERENCES

1. S.W. Herb *et al.*, Phys. Rev. Lett. **39**, 252 (1977).
2. R. Van Royen and V.F. Weisskopf, Nuovo Cim. A **50**, 617 (1967) [Erratum *ibid.* **51**, 583 (1967)].
3. A. Gray, I. Allison, C. T. H. Davies, E. Gulez, G. P. Lepage, J. Shigemitsu and M. Wingate, Phys. Rev. D **72**, 094507 (2005).
4. C.T.H. Davies *et al.* (HPQCD Collaboration), Phys. Rev. Lett. **92**, 022001 (2004).
5. S. Eidelman *et al.* (Particle Data Group), Phys. Lett. B **592**, 1 (2004).
6. M. Artuso *et al.* (CLEO Collaboration), Phys. Rev. Lett. **95**, 251801 (2005).
7. J. L. Rosner [CLEO Collaboration], arXiv:hep-ex/0512056.
8. J. Pivarski, Cornell University, Ph.D. thesis (unpublished).